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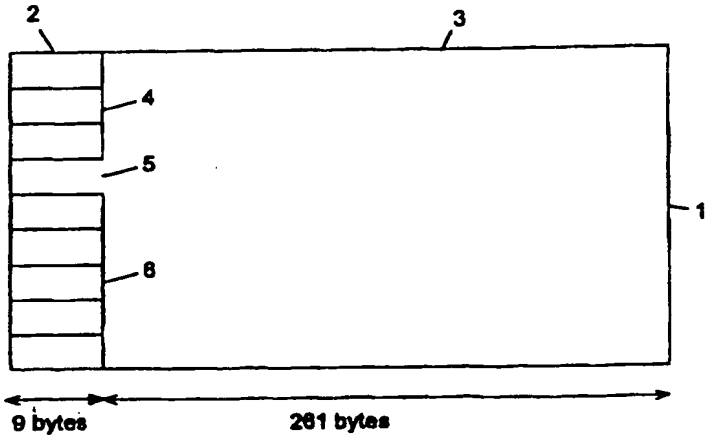
(54) Title: A DATA TRANSMISSION SYSTEM FOR THE TRANSMISSION OF A LARGE NUMBER OF TELEPHONE CHANNEL AND A METHOD IN CONNECTION THEREWITH



(57) Abstract

A data transmission system is used for the transmission of a large number of telephone channels between nodes in a transmissi network built as a Synchronous Digital Hierarchy (SDH), where a pulse frame (e.g. STM-1) contains a large number of bytes, each which can be used for the transmission of a telephone channel or of overhead signals for the administration of the system, and whe signals from a Plesiochronous Digital Hierarchy (PDH) are introduced into the pulse frame of the Synchronous Digital Hierarchy, so th the signals from the Plesiochronous Digital Hierarchy when introduced do not occupy all the bytes in said pulse frame. At least some the bytes of the pulse frame which are not occupied by said introduction, are used for the transmission of user-specified data signals. method of transmitting user-specified data signals in such a transmission network comprises transmitting the user-specified data signals one or more if the bytes in the pulse frame which are not occupied by the introduction of the PDH signals into the SDH.

A data transmission system for the transmission of a large number of telephone channels and a method in connection therewith

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The invention concerns a data transmission system for the transmission of user-specified data signals in a transmission network designed as a Synchronous Digital Hierarchy (SDH). A pulse frame (e.g. STM-1) contains a large number of bytes, each of which is used for transmitting a telephone channel or overhead signals for administering the system, and signals from a Plesiochronous Digital Hierarchy (PDH) are inserted into the pulse frame for the Synchronous Digital Hierarchy, so that the signals from the Plesiochronous Digital Hierarchy when inserted do not occupy all the bytes in said pulse frame.

The invention moreover concerns a method of transmitting user-specified data signals in such a transmission network.

The Synchronous Digital Hierarchy (SDH) is a very widely used transmission system for the transmission of a large number of telephone channels between nodes in a transmission network. The system permits transfer of asynchronous signals, such as e.g. signals from a Plesiochronous Digital Hierarchy (PDH) of 140, 34 and 2 Mbits/s, said signals being inserted or mapped into the SDH system. Standards prescribe how to place the individual signals in the individual bytes in the pulse frame of the SDH system.

Frequently, it is desirable to be able to transmit a user channel together the data proper (i.e. the telephone channels). It may e.g. be a monitoring channel for the equipment which is connected to a 2 Mbits/s section, it

being desirable to transmit the channel together with the associated 2 Mbits/s signals. So far, this has just been possible by using overhead bytes, as e.g. the overhead bytes called D1-D12 in the SDH system may be used in certain situations for transferring user channels. However, these can just be used for transferring data between two adjacent elements in the network, as each element decides for itself what it wants to use them for, and in certain situations they are reserved in advance for other purposes. It is thus not possible to use these bytes when other network elements are passed en route. Furthermore, the capacity of these bytes is rather limited, so that only small amounts of data can be transferred in this way. An example of this use of overhead bytes is known from WO 94/22249.

However, when the PDH signals are inserted into the pulse frame of the SDH system, they will not use all the bytes of the pulse frame because of the absent synchronization of the two systems. Thus, there is a plurality of empty bytes which are merely used as a filler between the bytes which contain PDH signals.

It is known from US 4 964 122 to use such bytes to transfer parity information, but this is information that only relates to the actual transmission of the data proper, and the bytes concerned are not accessible to a user.

The object of the invention is to provide a data transmission system where one or more user channels may be transmitted together with the telephone channels in the SDH system without otherwise affecting the system or its transmission capacity, and without the information being lost in network elements which are passed en route.

This is achieved according to the invention in that at least some of the bytes in the pulse frame which are not occupied by said insertion, are used for the transmission of user-specified data signals.

In case of inserting e.g. PDH signals at 2 Mbits/s into a virtual container VC-12 in the Synchronous Digital Hierarchy, the user channel together with the telephone channels in the VC-12 may also be connected through equipment which is not adapted to transfer the user channel, if only the VC-12 is not "opened" en route. The function may be used e.g. for ensuring that a monitoring channel for equipment connected to a 2Mbits/s section accompanies the associated telephone channels in the network. Further, this user channel/monitoring channel is easily accessed at the location(s) where the telephone channels are taken out of the system.

As stated in claim 2, it may be expedient in this situation to place the user channels in one or more of the bytes which are called fill bytes or stuffing bytes (R) in this insertion.

A particularly expedient embodiment of the invention is obtained when, as stated in claim 3, the user channels are placed in byte No. 34 and/or byte No. 104 in the VC-12 container, it being possible to transmit e.g. up to 7 user channels with 24 kbits/s, as stated in claim 4.

As mentioned, the invention also concerns a method of transmitting user-specified data signals in such a transmission network. When the user-specified data signals are transmitted in one or more of the bytes in the pulse frame which are not occupied by said insertion, the above-mentioned advantages are obtained.

Claims 6-8 define expedient embodiments of the method.

The invention will be described more fully below with reference to the drawing, in which

fig. 1 shows how an STM-1 frame in an SDH system is designed,
fig. 2 shows how 3 TUG's are multiplexed into a VC-4,

fig. 3 shows how the TU-12's and the TUG-2's are multiplexed into a TUG-3,

fig. 4 shows the linkage of VC-12's from 4 successive VC-4's, and

fig. 5 shows the structure of fig. 4 in greater detail.

A Synchronous Digital Hierarchy (SDH) is a digital transmission system which is used e.g. in connection with the transfer of a large number of telephone channels between nodes in a telecommunications network.

Like many other signals transmitted in a telecommunications network, SDH signals are a serial flow of logic 1's and 0's that may be divided into a sequence of bytes having 8 bits each. The signals are structured so that the transmitted bit flow may be subdivided into a plurality of channels for different applications. The basic structure of an SDH signal is a so-called Synchronous Transport Module at level 1 (STM-1), which is shown in fig. 1, from which it appears that the STM-1 signal may be illustrated as a frame 1 having 9 rows and 270 bytes in each row. The signals are transmitted one row at a time with the uppermost row first, and each row is transmitted from the left to the right. Each byte is transmitted with the most significant bit first.

As appears from the figure, the first 9 bytes 2 in each row are used by the SDH system itself even for overhead 4, 6 and pointers 5, respectively. The remaining 261 bytes 3 in each row constitute the transport capacity of the SDH system, but with part thereof being used also for overhead. The STM-1 frame is transmitted 8000 times per second, corresponding to a duration of 125 µs of each frame, and since each frame contains 9 rows each having 270 bytes of 8 bits each, the data rate is thus 155.520 Mbits/s. The 125 µs correspond to the sampling time in a digital telephone channel. A telephone channel is digitized with 8 bits, and this means that each byte in an STM-1 signal may be a telephone channel.

The transport capacity of the 9 rows of 261 bytes each constitutes a so-called virtual container designated VC-4. Frequently, the SDH system is used for transporting e.g. PDH signals, and in that case a VC-4 may e.g. contain a PDH channel of 140 Mbits/s, or it may be subdivided into a plurality of smaller virtual containers. It may e.g. contain 3 VC-3 each having a PDH channel of 34 Mbits/s or 63 VC-12 each having a PDH channel of 2 Mbits/s. An insertion structure, a so-called mapping, is defined for each of these signals, indicating how the signal is to fill the allocated location in the frame.

Fig. 2 thus shows how 3 VC-3 containers may be mapped into a VC-4. This is done by subdividing VC-4 into 3 units called TUG-3, each of which may contain a VC-3. As will be seen, the first three columns are used for overhead and stuffing bytes, while the 3 TUG-3 units are multiplexed into the remaining columns.

If 2 Mbits/s channels are to be transferred, each TUG-3, instead of a VC-3, contains 7 TUG-2 units, each of which

is in turn divided into 3 TU-12 units. It appears from fig. 3 how the TU-12's and the TUG-2's are multiplexed into TUG-3. It also appears that each TU-12 consists of 4 columns of 9 bytes each in each SDH frame, i.e. a total of 36 bytes for each 125 µsec.

Thus, a VC-12 might be included in principle in each TU-12; but to utilize the space better for overhead information, the TU-12's (i.e. 36 bytes) are linked in 4 successive VC-4 containers in practice. Hereby, each byte intended for overhead may be used for various items of overhead information, but, then, each of these is transferred only in every fourth VC-4. This linkage is shown in fig. 4.

This structure is shown more fully in fig. 5. I represents the bits which are used for the information proper, i.e. the telephone channels. R represents bits which are introduced to make the bit number come right when mapping the 2 Mbits/s channel into the VC-12. These bits are called stuffing bits. If a whole byte exclusively consists of stuffing bits, the byte might be called a stuffing byte. The other designations are various items of overhead information.

According to the invention, some of the bytes exclusively consisting of stuffing bits are used for transmitting user channels. These may e.g. be the bytes which are designated by 10 and 11 in fig. 5. In practice, 6 bits are used in each of the two bytes, the remaining two bits in each byte being used for parity comparison. It is hereby possible to transfer 7 user channels with 24 kbits/s.

One of the advantages of this system is that, when transmitting in the SDH system, the channels are packed together with the other data, which means that the channels

will be fed with certainty to the point where the VC-12 is unpacked, and this will usually also be the point where the information is to be used.

Although a preferred embodiment of the present invention has been described and illustrated, the invention is not retricted to this, but may be embodied in other ways within the scope of the subject-matter defined in the following claims.

Patent Claims:

1. A data transmission system for the transmission of a large number of telephone channels between nodes in a transmission network designed as a Synchronous Digital Hierarchy (SDH), where a pulse frame (e.g. STM-1) contains a large number of bytes, each of which may be used for transmitting a telephone channel or overhead signals for administering the system, and where signals from a Plesiochronous Digital Hierarchy (PDH) are inserted into the pulse frame for the Synchronous Digital Hierarchy, so that the signals from the Plesiochronous Digital Hierarchy when inserted do not occupy all the bytes in said pulse frame, characterized in that at least some of the bytes in the pulse frame which are not occupied by said insertion are used for transmitting user-specified data signals.

2. A data transmission system according to claim 1, where the signals from the Plesiochronous Digital Hierarchy comprise signals at 2 Mbits/s which are inserted into a virtual container VC-12 in the Synchronous Digital Hierarchy, characterized in that the user-specified signals are placed in one or more of the bytes which are called fill bytes or stuffing bytes (R) in this insertion.

3. A data transmission system according to claim 2, characterized in that the bytes in which the user-specified signals may be placed are byte No. 34 and byte No. 104 in the virtual container VC-12.

4. A data transmission system according to claims 1-3, characterized in that up to 7 user channels with 24 kbits/s may be transmitted in said bytes.

5. A method of transmitting user-specified data signals in a transmission network designed as a Synchronous Digital Hierarchy (SDH) where a pulse frame (e.g. STM-1) contains a large number of bytes, each of which may be used for transmitting a telephone channel or overhead signals for administering the system, and where signals from a Plesiochronous Digital Hierarchy (PDH) are inserted into the pulse frame for the Synchronous Digital Hierarchy so that the signals from the Plesiochronous Digital Hierarchy when inserted do not occupy all the bytes in said pulse frame, c h a r a c t e r i z e d in that the user-specified data signals are transmitted in one or more of the bytes in the pulse frame which are not occupied by said insertion.

6. A method according to claim 5, where the signals from the Plesiochronous Digital Hierarchy comprise signals at 2 Mbits/s which are inserted into a virtual container VC-12 in the Synchronous Digital Hierarchy, c h a r a c t e r i z e d in that the user-specified signals are transmitted in one or more of the bytes which are called fill bytes or stuffing bytes (R) in this insertion.

7. A method according to claim 6, c h a r a c t e r i z e d in that the user-specified signals are transmitted in byte No. 34 and/or byte No. 104 in the virtual container VC-12.

8. A method according to claims 5-7, c h a r a c t e r i z e d in that the user-specified signals are transmitted as up to 7 user channels with 24 kbits/s.

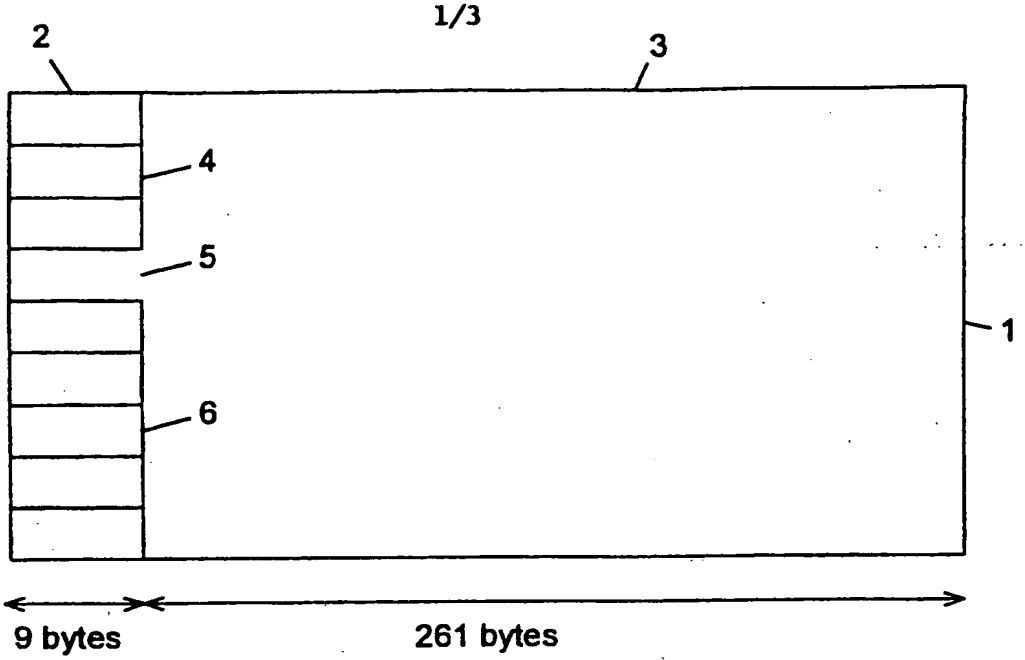
2
3
4
5
6
1
9 bytes
261 bytes

Fig. 1

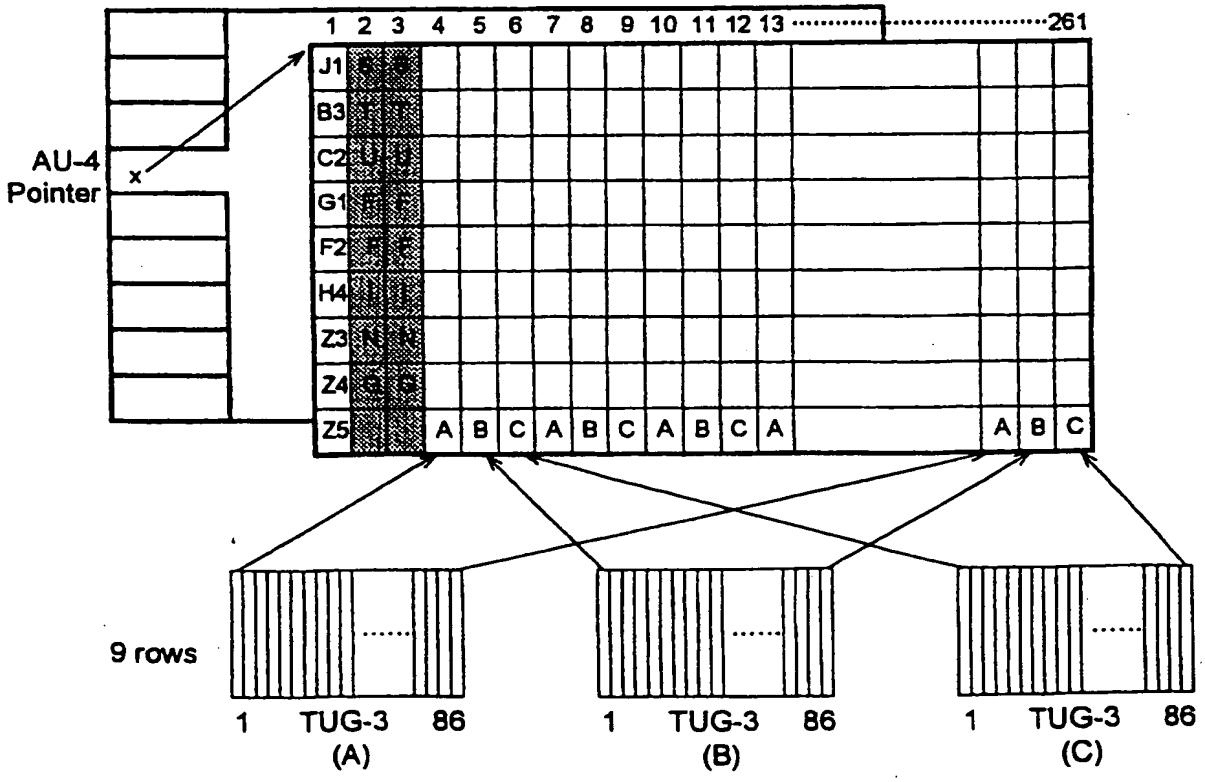
1 2 3 4 5 6 7 8 9 10 11 12 13 261
J1
B3
C2
G1
F2
H4
Z3
Z4
Z5
A B C A B C A B C A A B C
AU-4
Pointer
x
9 rows
1 TUG-3 86
(A)
1 TUG-3 86
(B)
1 TUG-3 86
(C)

Fig. 2

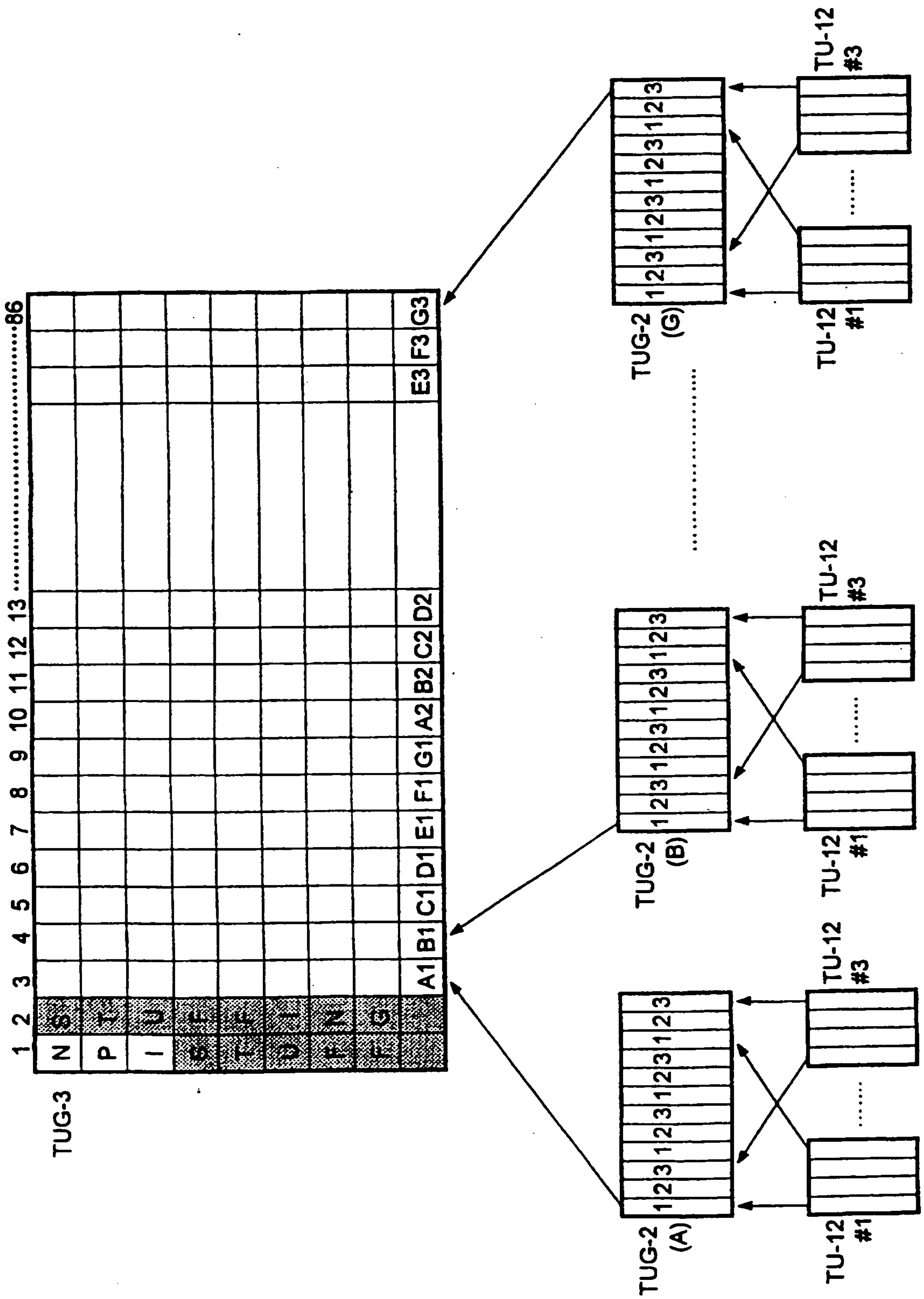
TUG-3
1 2 3 4 5 6 7 8 9 10 11 12 13 86
N P I
S T U F F I N G
A1 B1 C1 D1 E1 F1 G1 A2 B2 C2 D2 E3 F3 G3
TUG-2 (A)
TUG-2 (B)
TUG-2 (G)
1 2 3 1 2 3 1 2 3 1 2 3 1 2 3 1 2 3 1 2 3 1 2 3
TU-12 #1
TU-12 #3

Fig. 3

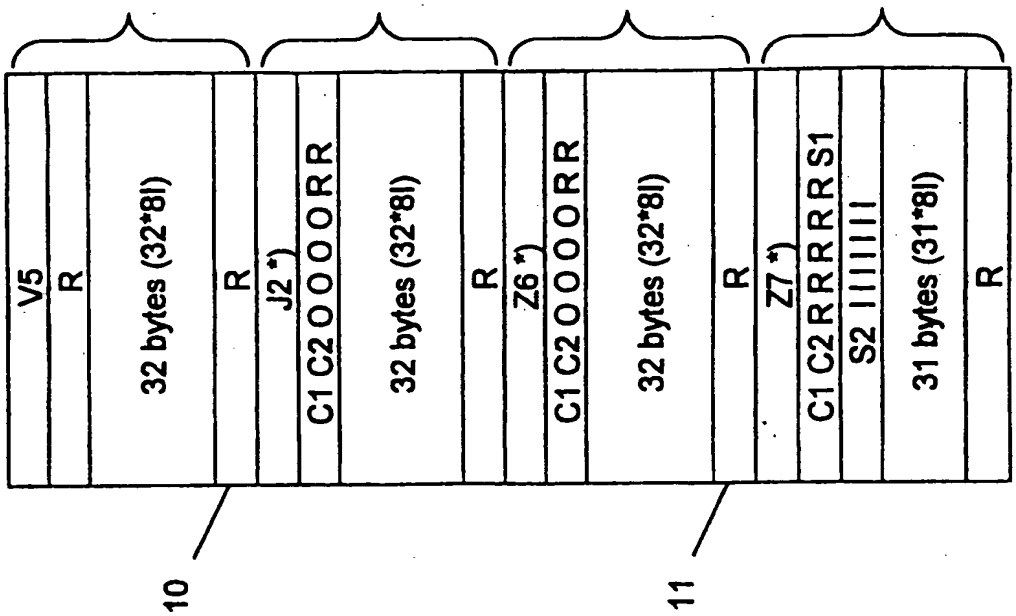
V5
R
32 bytes (32*8I)
R
J2 *)
C1 C2 O O O O R R
32 bytes (32*8I)
R
Z6 *)
C1 C2 O O O O R R
32 bytes (32*8I)
R
Z7 *)
C1 C2 R R R R S1
S2 I I I I I I I
31 bytes (31*8I)
R
10
11

Fig. 5

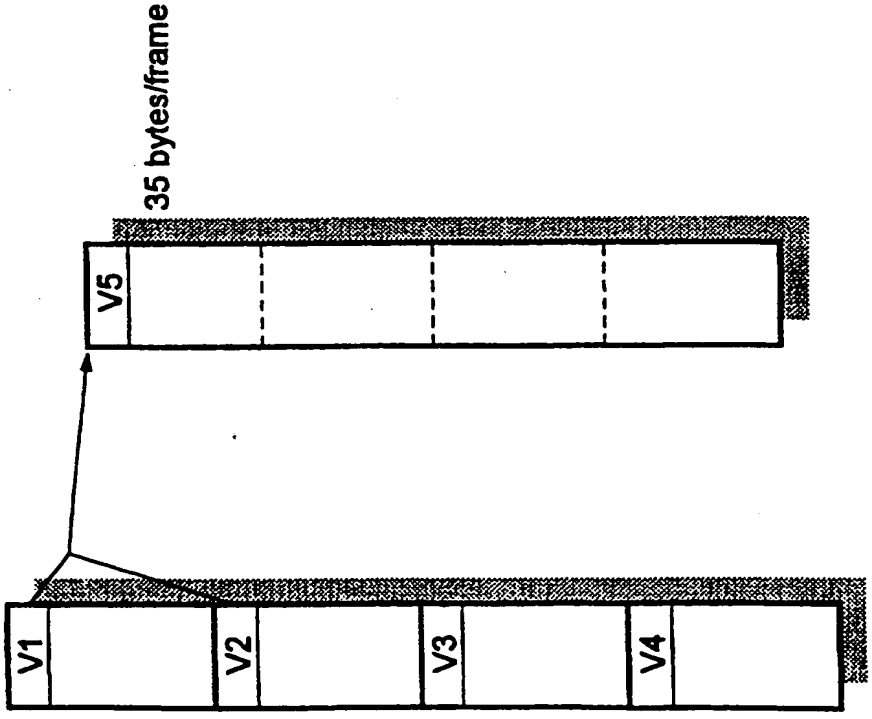
35 bytes/frame
V5
V1
V2
V3
V4

Fig. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/DK 96/00484

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: H04J 3/07
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: H04J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 9515042 A1 (DSC COMMUNICATIONS CORPORATION), 1 June 1995 (01.06.95), abstract ---	1-8
A	GB 2260469 A (NOKIA TELECOMMUNICATIONS OY), 14 April 1993 (14.04.93), abstract ---	1-8
A	US 5282195 A (DAVID F. HOOD ET AL.), 25 January 1994 (25.01.94), abstract --- --------	1-8

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
25 April 1997	28.04.97
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Mikael Sollerhed Telephone No. +46 8 782 25 00

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/DK 96/00484

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9515042 A1	01/06/95	CA 2177264 A	01/06/95
		EP 0732015 A	18/09/96
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US 5282195 A	25/01/94	NONE	